ARW Core Nested Simulation

For this exercise, you will configure and run a short, nested simulation with the WRF ARW core. As with the EMS introduction exercise (Lab #2), step-by-step directions will guide you through the process of setting up and running the nested simulation, and there will be a few questions along the way that will require you to investigate various parts of the system. The critical learning objective in this exercise is the process of running a nested simulation and post-processing the forecast data. If time allows, you will have an opportunity to examine the results.

The ARW core officially supports synchronous 1- and 2-way nesting, which is neatly integrated into the WRF EMS. For the uninitiated, 2-way nesting allows for information from a higher resolution child domain to be fed back to the parent domain. The parent provides the lateral boundary conditions to the nested domain at each time step, and the nested domain is allowed to integrate forward in time with the results fed back onto the parent domain. In the case of 1-way nesting, this feedback mechanism is turned off so while the parent provides the boundary conditions to the nested domain, there is no exchange of information from the nest back to the parent. When running the ARW core, all nesting is concurrent with the parent domain, meaning that the nest runs at the same time as the outer domain. The benefit of concurrent nesting is that the boundary conditions for the nested domain are provided at every parent domain time step. The limitation of this method is that it requires more physical memory on your workstation in order to run multiple domains simultaneously.

The steps in running an ARW core nested simulation are described in the following sections; however, the basic sequence includes:

1. Configuring your nested domains with the SI GUI
2. Run the wrf_prep script with "--nests" option to initialize the simulation
3. Edit the wrf_run configuration files for the simulation
4. Run the wrf_run script with the "--nests" option to run your simulation
5. Run the wrf_post script with the "--domain" flag to post process the forecast files.

Step I Create a computational domain

The static initialization GUI is used to create the domains for ARW core nested runs. This process is nearly identical to creating a single computational domain except for an additional step wherein the nested domain(s) are defined. The GUI can support multiple domains at the same nest level (no overlapping nest), or multiple nest levels (telescoping).

For this exercise, you will create a single nested domain. The specifications for both domains are provided in Appendix A. Screen captures of the SIGUI horizontal domain configuration windows are also provided in appendix B.

Do: % cd $WRF_RUN

Do: % sigui

The name that you provide for your domain in the SIGUI can be whatever you like.

Follow the domain specifications in Appendix A for your configuration. When your domain is configured, go ahead and run the localization, which should take a few minutes. When the localization has completed exit out of the SIGUI.

Do: % cd $WRF_RUN/<your domain>

Step II Process the initialization files

After using the SI GUI tool to configure your nests, the next step is to run wrf_prep from your domain directory. If this were not the highly-controlled laboratory exercise that it is, then this would be the point that you decide which, if any, of the nested domains will be used in your simulation. For example, just because you created four domains doesn't mean that you need to use them all.

For this exercise, two domains were created and identified as d01 and d02. Domain 01 (d01) is always the Mother of All Domains (MOAD) and does not require that any special options be passed to wrf_prep; however, if you want to use any of the nested domains you must pass the "**--nests**" flag, which is followed by the domains you want to initialize, separated by a comma. This flag tells the wrf_prep routine to process the initialization files for a nested run and update the necessary configuration files.

For example (not for this lab):

% wrf_prep [other arguments] --nests 2,3,4

Or

% wrf_prep [other arguments] --nests 3

Or

% wrf_prep [other arguments] --nests 2,3

Got it? Now let's run wrf_prep for your nested domain.

Do for this exercise:

```
% wrf_prep --dset gfsgrb2 --nfs --date 20070120 --cycle 06 --sfcdset ssthr --snfs --nests 2 --length 12
```

Once wrf_prep has completed you can move on to the next step.

Step III Configure the Simulation

The conf/wrf_run directory contains configuration files with the default settings for your primary and nested runs. If you look inside these files you will notice parameters that are designated by "NESTING". These parameters can have different settings for each nested domain. *You will not need to edit the configuration files for this exercise as you will be using the default values.*

The convention by which values for each of the domains are specified is:

PARAMETER = d01, d02, d03, d04, …, dn

Where d01,d02,d03,... represent the value for domains 01 (MOAD), 02, 03, etc.

Thus, for example:

CU_PHYSICS = 1, 3, 1, 0

Specifies the use of cumulus scheme **1** (Kain-Fritsch) for domains 1 and 3, cumulus scheme **3** (Grell-Devenyi) for domain 2, and NO cumulus scheme (**0**; explicit) for domain 4.

Note that if you do not have enough values specified, i.e,

CU_PHYSICS = 1

And you want to include domain 2 as a nest, then the LAST value specified in the list (1) will be used. You will receive a warring message when you execute the "wrf_run" command although you may ignore it if you wish

Question #1: Please identify the following default settings as specified in the configuration files.

Model Physics	Parent	Nest
Cumulus scheme		
Microphysics scheme		
PBL Scheme		
Land Surface Scheme		
Short Wave Radiation		
Long Wave Radiation		
Model Output Information	**Value**	
Forecast Output Frequency		
Precip Accumulation Frequency		
Model Grid Information	**Value**	
Feedback		

Step IV Run the simulation

The purpose of the wrf_run script is to create the initial and boundary conditions used for the simulation, and then execute the model simulation. By default, wrf_run will only run the primary domain (MOAD) unless the "--nests" flag is passed. Passing the "--nests" flag not only tells wrf_run which nest(s) to run but also the

start hour relative to the parent domain, and the length of the forecast. Therefore, it is possible to run a nested simulation over a shorter period than that of the parent domain depending on the arguments you pass to "--nests".

The arguments to the "--nests" option are:

--nests Domain#[:Start:Length],...

Where,

Domain# The nested domain you wish to run

Start The number of hours after the start of the primary domain when you wish to begin the nested run

Length The length, in hours, of the nested simulation

Note that

1. "Domain#" is mandatory but "Start" and "Length" are optional.
2. Both the Start and Length values are preceded by a colon (:).
3. Multiple Domains with unique Start and Length values are separated by a comma.
4. In the absence of a start or length value the simulation will default to the entire length of the primary forecast

Do: % wrf_run –SMDM --nests 2:03:06

Question #2: What does the "--nests 2:03:06" flag mean??

At this point the model will take some time to finish depending on the number and configuration of the nested domains. While the model is running, you may follow along with its progress by executing the command specified in the window.

Step V Post process the forecast files

The wrf_post.pl script is used to post-process WRF model forecasts from either the NMM or ARW cores. By default, the WRF EMS forecast files are in netCDF format on native model levels. The wrf_post.pl script will allow users to create GRIB formatted files containing many additional fields and interpolated to isobaric coordinates, which can be processed further and the resultant files shipped to other systems.

To summarize, the wrf_post.pl routine:

- Post-processes WRF model forecasts from either the NMM or ARW cores in netCDF format on model native coordinate levels,
- Can output fields on 47 pressure levels including 2, 3, 5, 10, 20, 30, 50, 70, 75, 100 to 1000 every 25, and 1013 hpa,
- Handles forecast files with up to 1-minute temporal frequency,
- Is capable of producing model output fields in a variety of formats including GRIB 1, GRIB 2, BUFR, GEMPAK grid files, GEMPAK sounding files, BUFKIT, and GrADS,
- Can send processed forecast files to remote systems via FTP, COPY, SCP, or RCP depending upon the user's needs, and
- Will allow users to fine-tune the frequency of the files being processed into each format.

Following a successful nested simulation with the ARW core, forecast files for each domain will be located in the **wrfprd** directory with each domain identified by a "_d0#" in the filename. You can process each nest individually by passing the "--domain #" option to wrf_post. For example:

% wrf_post --domain 2 [*other options*]

Passing "--domain 2" as in the above example will process only those files for nested domain #2. In the absence of the "--domain" option wrf_post will default to domain #1. If you have multiple nests to process you must run wrf_post for each domain.

You can also turn ON/OFF the post proceeding options for individual domains in the wrf_post.conf file for nested ARW core runs. Those fields designated by "Nested ARW Core" may contain multiple entries separated by a comma. The multiple entries are for use with the domain forecast files output by the ARW core when running synchronous 1- and 2-way nested simulations, where each entry is tied to a specific domain.

For example:

GRADS = MOAD (d1), Nest d2, Nest d3, Nest d4, ..., Nest dN

or

GRADS = Yes, No, Yes, No

The above example specifies that you want to convert forecast files from Mother of all Domains (MOAD, d1) and domain (nest) #3 to GrADS format, but not nested domains d2 and d4. Remember that you need to tell wrf_post which domain to process by passing the --domain # flag. Not passing this flag defaults to the MOAD when processing. Passing the corresponding command line flag to wrf_post overrides the settings in this file. So, passing "--domain 2 --gempak" will turn ON the GrADS processing for nested domain d2.

Do: % wrf_post --domain 2 --grads

While you are waiting for wrfpost to process the nested domain you can view images of bother the parent and nested domain by pointing your browser to:

wrf/util/saws/lab4/web/moad/index.htm

and

wrf/util/saws/lab4/web/nest/index.htm

End of Lab #4

Appendix A: ARW Nested Experiment Model Configurations

Initialization Dataset:

Date:	20 January 2007
Cycle run:	0600 UTC GFS Model forecast
Data set	0.5 degree Global GFS Grib 2 format
BC frequency:	3 hourly

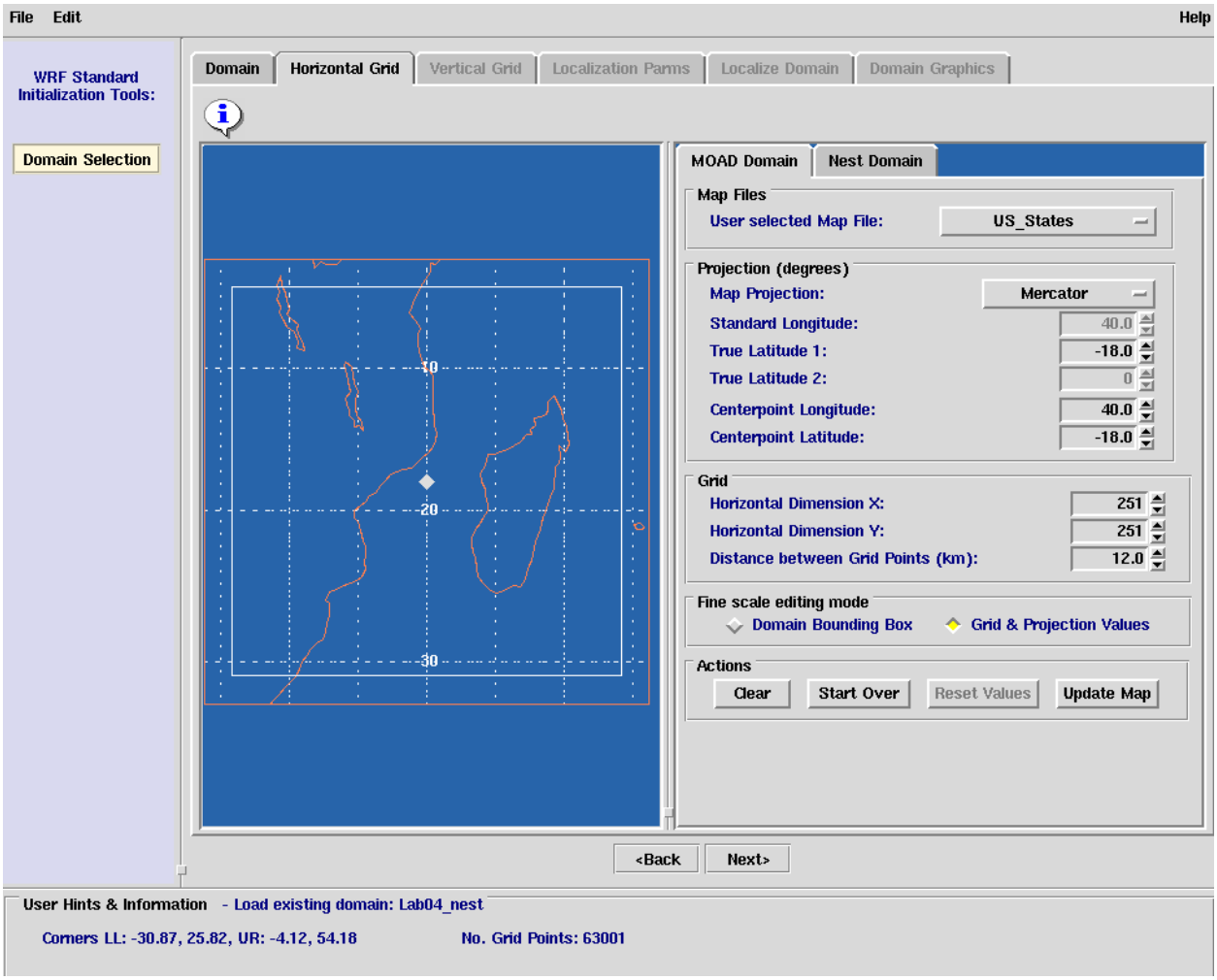
Model Domain:	**MOAD**	**Nest**
Grid spacing:	12km	4km
Grid points(IM x JM):	251x 251	153x153
I,J Start	1, 1	100,100
I,J Stop	251, 251	151, 151
Model levels:	31	31
Grid Center:	40E 18S	38E 19S
Map Projection	Mercator	Mercator

Model Forecast Details:

Forecast length:	12 hours	6 hours
Dynamics	Non-Hydro	Non-Hydro

Appendix B: What your horizontal domain configuration window should look like

ARW Core Parent Domain:



ARW Core Nested Domain Window: